Customer No. 27061
Confirmation No. 5238

Patent
Attorney Docket No. GEMS8081.228

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Hariharan et al.
Serial No.	:	10/711,239
Filed	:	September 3, 2004
For	:	METHOD AND APPARATUS OF MULTI-ECHO MR DATA ACQUISITION WITH NON-DISCRETE FLIP ANGLE TRAIN
Group Art No.	:	2859
Examiner	:	Megann E. Vaughn

CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10

I hereby certify that, on the date shown below, this correspondence is being:

Mailing

□ deposited with the US Postal Service in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

37 CFR 1.8(a) □ with sufficient postage as first class mail

37 CFR 1.10 □ As "Express Mail Post Office to Addressee" Mailing Label No.

Transmission

■ transmitted by facsimile to Fax No.: 571-273-8300 addressed to Examiner Megann E. Vaughn at the Patent and Trademark Office.

Date: February 20, 2007

/Robyn L. Templin/
Signature

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRE-APPEAL BRIEF CONFERENCE REQUEST

Dear Sir:

Applicant requests review of the final rejection in the above-identified application. No amendments have been made with this request. The request is being filed with a Notice of Appeal. The review is requested for the reasons as set forth hereinafter:

REMARKS

I. Claims 1 and 21 Rejections

The Examiner rejected claims 1 and 21 under 35 U.S.C. §102 (b) as being anticipated by LeRoux et al. (5,345,176). The Examiner has failed, however, to establish that the cited reference teaches each and every element of the claims and therefore the §102(b) rejection is procedurally defective. Claims 1 and 21 call for, in part, a computer programmed to determine, in real-time, a respective flip angle for each data acquisition pulse of pulse sequence for multi-echo acquisition of MR data matched to a given target tissue and a given scan prescription to reduce ringing artifacts from amplitude decay of the multi-echo acquisition.

The technique called for in claims 1 and 21 above is described at Para. 31 with respect to Fig. 2 of the Application:

> [C]oefficient values may be accessed to generate a flip angle train matched to a target tissue identified for inspection and the parameters of a scan to acquire data with contrast of the target tissue. Technique 70 preferably begins at step 72, and an identification of input parameters including tissue type, tissue T1 and T2 values, and Echo Spacing Time (EST) among others occurs at step 74. An amplitude versus total echo train time relationship is determined at 76. The amplitude versus total echo train time relationship is determined through a numerical solution of Bloch Equations.

Application, Para. 31 (emphasis added) and Fig. 2.

Furthermore, it was "also contemplated that the flip angle expression may be determined on-the-fly." *Id.*, Para. 39. As such, Applicant describes and calls for in claims 1 and 21 a flip angle train that is generated based on a given target tissue and a given scan prescription which is used, in real-time, to determine a pulse-sequence for multi-echo acquisition of MR data which reduce ringing artifacts from amplitude decay.

LeRoux et al. '176 Does Not Teach Reducing Ringing Artifacts from Amplitude Decay

LeRoux et al. '176 describes a technique for stabilizing the oscillating amplitude of early NMR echo signals, which is "accomplished by modifying the amplitude of the nutation angle produced in the spins by the corresponding RF refocusing pulses." *LeRoux et al. '176,* Abstract. "This stabilization is relaxed for the first RF refocusing pulse so that its maximum RF power can be reduced relative to that of the other RF refocusing pulses." *Id.*

LeRoux et al. '176 teaches stabilizing the oscillation of spin-echo signals by modifying one or more RF refocusing pulses in a series of refocusing pulses. *LeRoux et al., '176,* Col. 3, lns. 14-17. An optimal rate of decay is illustrated by dashed line 315 in NMR spin echo signals 301-304. *Id.* Col. 7, lns. 23-25. LeRoux et al. '176 teaches that for a conventional FSE (fast spin echo) sequence

the NMR echo signals 301-304 do not decay smoothly along dashed line 315 and "the magnitude of the NMR signals 301-305 (sic) may oscillate significantly below this optimal T2 decay curve 315" *Id.* Col. 7, lines 45-49 (emphasis added). LeRoux et al. specifically states that it is "an objective of the present invention to produce selective RF refocusing pulses which will eliminate such oscillations in the NMR echo signals for all spins in the excited slice." *Id.*, Col. 8, lns. 9-12 (emphasis added). LeRoux et al. '176 illustrates the oscillation effect in Figure 4 where, for a high tip angle of 180 degrees the oscillation "does not arise," but when the "tip angle is reduced below 180°, the oscillations in the early NMR signal magnitudes become very significant." *Id.*, Col. 7, lns. 56-63, Furthermore, "[a]s the tip angle is further decreased, more NMR echo signals are affected before an equilibrium condition is reached, but oscillations become less pronounced." *Id.*, Col. 7, lns. 63-66 and Fig. 4 (emphasis added). Bloch equations are used to determine the desired input signals s_i at various portions of the sequence [i.e. t_0, t_1, etc...as in lines 20-30] "as a function of the desired output signal (S) to produce a set of smooth curves as described and shown in the above cited copending patent application." *Id.*, Col. 9, lns. 36-38.

The copending application referred to in LeRoux et al. '176 is Ser. No. 920,952, which subsequently issued as LeRoux et al. (5,315,249). LeRoux et al. '249 likewise illustrates optimal decay curve 315 of Fig. 3 and teaches modifying one or more RF refocusing pulses "by changing their modulation envelope such that the magnitude of the NMR spin-echo signals does not oscillate." *LeRoux et al., '249,* Col. 3, lns. 2-5 and Fig. 3. "[A]s the tip angle becomes smaller, the fluctuations in the NMR echo signal magnitude increase." *Id.*, Col. 3, lns. 16-18. "RF refocusing pulses in an FSE pulse sequence can be calculated such that all the resulting NMR spin echo signals may be stabilized." *Id.*, Col. 3, lns. 20-22. "Fig. 6 is employed to determine the RF signal strength (s) required to produce stabilized NMR echo signals." *Id.*, Col. 10, lns. 40-43. Additionally, "NMR echo signals are stabilized to a substantially smoothly decaying amplitude by altering the flip angled produced." *Id,* Claims 1 and 2 (emphasis added).

Thus, LeRoux et al. '176 and parent LeRoux et al. '249 disclose an NMR system with pulse control means in which a series of NMR signals are stabilized from oscillation. Both LeRoux et al. '176 and LeRoux et al. '249 teach a method wherein NMR spin echo signals are decayed optimally along curve 315. The stabilization requirement of LeRoux et al. '176 is relaxed for the first RF refocusing pulse so that its maximum RF power can be reduced relative to that of the other RF refocusing pulses. Accordingly, the ringing artifacts from **amplitude decay** are not addressed by LeRoux et al. '176 or its parent LeRoux et al. '249.

LeRoux et al. '176 Does Not Teach Flip Angle Selection Based on Target Tissue and Scan Prescription

The Examiner alleged that LeRoux et al. '176 "discloses in column 7, lines 23-36 that the pulse sequnce (sic) is choosen (sic) for specific tissue types, i.e. the pulse sequence is matched up to the knee joint muscle tissue." *Final Office Action*, 11/17/06, pg. 7. However, LeRoux et al. '176 does not consider or utilize target tissue parameters (i.e. T1 and T2) in developing a flip angle train as the Examiner alleged. LeRoux et al. '176 describes contrast generation by appropriately selecting the echo time (TE):

> [A] common strategy in FSE NMR imaging is to enhance the contrast in certain tissues over other tissues by judiciously selecting an effective echo time. This effective echo time is determined primarily by the actual echo time (TE) of the central, or low-order, views that dominate the image contrast. For example, to enhance muscle tissue in the image of a human knee joint, the first spin echo signals may be encoded to a low-order phase encoding value in each shot because the T2 decay rate of muscle tissue is high and the shortest possible effective echo time (TE) is desired. On the other hand, to produce an image in which the fluids in the knee joint are enhanced, the low-order phase encoding view may be acquired from later echo signals which have a much longer echo time TE. The T2 decay rate of joint fluids is much less than that of muscle tissue, and as a result, these fluids will contribute proportionately more signal and their contrast will be enhanced in comparison with that of muscle tissue. *LeRoux et al., '176,* Col. 7, lns. 26-44.

Accordingly, LeRoux et al. '176 teaches a technique for enhancing contrast generation by choosing TE appropriately. The T2 decay rate is a result of tissue type, as is commonly known in the art, but LeRoux et al. '176 does not teach or suggest selecting a flip angle train that is calculated from, or is a result of knowing, the tissue type to be imaged. The technique disclosed by LeRoux et al. '176 in fact has nothing to do with selecting flip angles based on tissue type. Accordingly, the Examiner has clearly misapplied the teaching of the reference, as LeRoux et al. does not "determine, in real time, a respective flip angle matched to a given target tissue and a given scan prescription" as called for in claims 1 and 21.

The "Polynomials" Taught by LeRoux et al. '176 are not "Polynomial Expressions for Given Target Tissue and Scan Prescription"

Claim 21 further calls for, in part, a determination of the "respective flip angle from a selection of one of a number of stored polynomial expressions of available flip angle trains, the selected polynomial expression being most optimal of the number of stored polynomial expressions for the given target tissue and the given scan prescription." The Examiner alleged that this element is taught by LeRoux et al. '176 at Col. 8, lns. 30-60. *Final Office Action*, 11/17/06, Pg. 4. However, the polynomial expressions of LeRoux et al. '176 are not dependent on a given target tissue and a scan prescription.

In LeRoux et al. '176, polynomials describe signal amplitude S_i at each echo as a function of flip angles. "[F]or each steady state NMR echo signal S_i determine (sic) the required RF refocusing pulse flip angle θ_i." *LeRoux et al., '176,* Col. 8, lns. 23-24. "The result is a unique sequence of nutation angles θ_i that will produce a stabilized echo signal output S." *Id.,* Col. 8, lns. 24-26. "[T]he Bloch equations permit the recursive calculation of echo signal amplitude S_i." *Id.,* Col. 27-28. Thus, the "polynomials" referred to by LeRoux '176 at Col. 8, lns. 30-60 describe signal amplitude as a function of flip angles and are not dependent on target tissue or a given scan prescription.

The polynomials of claim 21, on the other hand, derive from "a database with coefficient values of a polynomial expression of a flip angle chain." *Application,* Para. 31. "[T]he coefficient values may be accessed to generate a flip angle train matched to a target tissue and identified for inspection and the parameters of a scan." *Id.* "Technique 70 may be used to determine and store values for coefficients for a multi-order flip angle polynomial expression." *Id.* "Flip angle train 106 has a linear segment 108, a non-linear segment 110, and a constant segment 112." *Id.,* Para. 36. [A] polynomial fit is applied to segment 110 to determine a polynomial expression or expression that substantially describes segment 110." *Id.* "The polynomial fit is applied to the non-linear segment 110 of flip angle train 106 to yield flip angle values set forth in curve 114 of Fig. 6." *Id.,* Para. 37. "Coefficients of the polynomial expression fit 114 to the non-linear segment 110 of the flip angle train at step 86 are stored in a database at step 88." *Id.,* Para. 39 and Fig. 2. "In this manner, coefficient values for a number of polynomial expressions may be stored and recalled for an MR scan to provide flip angles matched to a tissue type and specific prescription parameters." *Id.,* (emphasis added). Thus, the polynomials called for in claim 21 describe a portion of a flip angle train that are dependent on (1) tissue type and (2) scan prescription, and are entirely different than the "polynomials" as taught by LeRoux et al. '176, as set forth in the last line of claim 21.

Thus, the Examiner has failed to show every element in rejecting claims 1 and 21 and Applicant requests withdrawal thereof.

II. Status of Claim 1

The status of claim 1 is unclear and Applicant requests clarification thereof. On February 15, 2006, in response to a restriction requirement, claim 1 was submitted in original form. Applicant amended claim 1 on June 21, 2006. However, the Examiner refused entry of the claim amendments in the Office Action dated August 16, 2006 and stated, "amended claim 1 is withdrawn from consideration as being directed to a non-elected invention, and claim 1 filed on (sic) will be prosecuted in the present Office Action." *Office Action,* 8/16/06, Pg. 3. The Examiner did not include the date on file for claim 1. On October 16, 2006, Applicant responded and resubmitted original claim 1 because the Examiner refused entry of Applicant's amendment. Accordingly, claim

1 was labeled as "original." However, in the Final Office Action dated November 17, 2006, despite refusing entry of the claim amendments of March 22, 2006 and subsequently prosecuting claim 1 in its original form, the Examiner stated "since the intent of applicant is clear with respect to claim 1, the examiner has considered the status identifier of claim 1 to be –currently amended-instead of original." *Final Office Action,* 11/17/06, Pg. 2.

Applicant is confused regarding the status of claim 1, and surely the Board of Appeals & Interferences will be all the more confused. It is unclear whether the claim amendments of March 22, 2006 have been entered or not. If the claim amendments were not entered, as the Examiner stated on August 16, 2006, then claim 1 remains in its original form and should be identified accordingly. On the other hand, if the claim amendments were entered, then the identifier should be "previously presented" related to the amendments submitted on March 22, 2006, but the claim should then have been examined according to the amended language that was submitted therein. The MPEP requires "[a]ll claims being currently amended in an amendment paper shall be presented in the claim listing, indicate a status of "currently amended," and be submitted with markings to indicate the changes that have been made relative to the immediate prior version of the claims." MPEP §714(c)(2) (emphasis added). Because the Examiner refused entry of the claim amendments, the "immediate prior version" of claim 1 is the original form that was submitted on February 15, 2006. In order to identify claim 1 as "currently amended" as suggested by the Examiner, the claim will show neither deletions nor additions. Applicant requests Panel review and to direct clarification thereof.

Applicant appreciates the Panel's consideration of these Amendments and respectfully requests allowance of all pending claims, and clarification that claim 1 is in "original" form.

Respectfully submitted,

/Timothy J. Ziolkowski/

Timothy J. Ziolkowski
Registration No. 38,368
Phone 262-268-8181
tjz@zpspatents.com

Dated: February 20, 2007
Attorney Docket No.: GEMS8081.228

P.O. ADDRESS:
Ziolkowski Patent Solutions Group, SC
136 South Wisconsin Street
Port Washington, WI 53074
262-268-8100